

Setting and Age of Gold and Copper Deposits in La Zanja Volcanic Field, Northern Peru

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La Zanja Volcanic Field (LZVF) contains gold reserves of more than 500,000 oz of gold in two main deposits, San Pedro Sur and Cerro Pampa Verde, and copper resources of 50 Mt @ 0.31% Cu and 0.12% Mo at Castrejon. La Zanja comprises felsic to intermediate volcanic units of the Calipuy Group (Cenozoic) approximately 200 km from the active subduction margin between the Nazca and the South American plates.

New U-Pb dates on igneous and detrital zircon, and detrital rutile indicate LZVF ranges in age from ~36.02 to ~10.25 Ma. Twelve episodes have built the stratigraphy of La Zanja district. The oldest units (~36.02 to ~34.26 Ma) are ignimbrites produced by large dacitic to rhyolitic explosive eruptions. These units are characterized as plagioclase-rich, quartz-rich, and lithic-poor. A second phase of rhyolitic explosive eruptions (~33.50 Ma) produced the quartz-rich San Pedro Ignimbrite, which is the thickest and most extensive ignimbrite recognized at La Zanja. This ignimbrite hosts the main high-sulfidation gold deposits, low-sulfidation gold and silver deposits, and Cerro La Zanja porphyry copper deposit. The ignimbrites were probably erupted from calderas but their sources have not been identified. An andesitic effusive episode (~30 Ma) produced pyroxene-phyric and plagioclase-phyric lavas that covered the ignimbrites. The occurrence of sedimentary units suggests a break in the volcanic activity of at least ~3.53 m.y. A new rhyolitic explosive event (~24.76 Ma) produced another ignimbrite, contemporaneous with the Cerro La Zanja (~24.12 Ma) porphyry copper deposit which is hosted by San Pedro Ignimbrite (~33.50 Ma).

Multiple diorite intrusions were emplaced between ~22.47 to 17.55 Ma. The Castrejon porphyry copper deposit (~19.30 Ma) was formed during this intrusive episode but the main host is the Castrejon Ignimbrite (~32.53 Ma). During this break in volcanic accumulation, erosion locally generated volcanogenic sedimentary units. Andesitic block and ash flow deposits, plagioclase-phyric lavas, andesite domes, and volcanogenic sedimentary facies (>~18.44 Ma) define multiple small volcanic centers within La Zanja district. The ages and the location of the andesitic volcanic centers suggest a possible migration of the andesitic volcanism from southwest to northeast (~18.44~13.46 Ma).

Isolated dacite domes (15.89–11.27 Ma) occur along the NW-trending Culaque fault. These dacite domes were emplaced in two phases separated by a break of ~1.79 m.y., during which the high-sulfidation gold deposits (San Pedro Sur, Pampa Verde, and Cerro La Zanja; ~11.88–12.80 Ma, Ar/Ar alunite) formed in the San Pedro Ignimbrite. Although close to the young dacite domes (~11.67–~11.27 Ma) and hosted by San Pedro Ignimbrite (~33.50 Ma), the hydrothermal systems that produced San Pedro Sur, Cerro Pampa Verde, and Cerro La Zanja high-sulfidation gold deposits were not strictly synvolcanic. Instead, the Culaque fault appears to have been the main localizing feature that controlled this gold mineralization. The NW and NE low-sulfidation gold and silver vein systems have not been dated but the field relationships show these veins cut the high-sulfidation deposits and are therefore younger than ~11.88 Ma.